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Factsheet

HEAT STRESS IN CAGED LAYERS

(Revision of Factsheet "Heat Stress in Caged Layers", June 1988)

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INTRODUCTION

A caged layer, eating a normal ration and laying at a rate of 80%, will produce about 180 kilocalories of heat every day. Thus 10,000 layers will produce as much heat in a day as a furnace burning 231 litres of fuel oil. This means that on a warm summer day, a ventilation failure could result in a rise in the temperature, within the building, of 16°C in one hour. When the hen is in a comfortable environmental temperature (21-25°C) she will lose most of that heat by sensible means. Sensible heat loss is by three pathways: (1) **conduction**, whereby she touches a surface cooler than her own surface, for example the floor of the cage or the sides of a cool water trough; (2) **convection**, whereby a cool breeze carries heat from her body; and (3) **radiation**, the electromagnetic process whereby heat moves from a warmer to a cooler surface without using a medium (heat flows to the earth from the sun by radiation).

When the laying hen is in a very warm environment (28-35°C) she must work at losing the heat she produces. She does so by raising and spreading her wings and separating herself from other birds if possible. Despite her best efforts, however, heat loss by sensible means decreases and loss by latent means (**evaporation**) increases. One reason is that, as the environmental temperature increases, the difference between the temperature of the hen's body (41°C) and the surrounding air, equipment and walls becomes very small. Thus she cannot readily lose heat by sensible means and must do so by evaporation. A second reason is that the evaporation of water uses a lot of heat - it is an effective way for her to keep cool.

How does she go about evaporating water since she does not have sweat glands? She does it by panting, similar to the dog. The hen can easily increase her respiration rate to 10 times normal and, in addition, indulges in gular (throat) flutter to aid in evaporation. One can readily see the rapid throat movement in panting birds. This throat flutter moves air in and out of the throat area and increases evaporation without such air entering the lungs. During a hot, dry day this is very efficient but on a hot, humid day the hen must pant more to keep cool. This evaporation means that a readily available supply of clean, fresh water is vital. The relative importance of sensible and latent heat loss is illustrated in Figure 1.

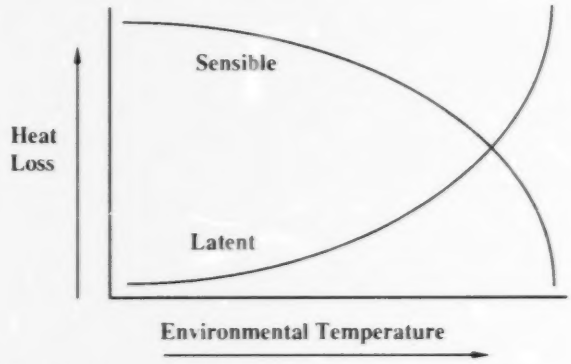

Figure 1. Schematic outline of heat loss with increasing environmental temperature.

The heat from the laying hen, either in sensible or latent form, must be removed from the building. What can be done to facilitate heat removal from birds and buildings in hot weather?

VENTILATION

Ventilation does the following:

1. Exhausts moisture laden air.
2. Brings in an equal amount of outside air.
3. Directs inlet air equally to all areas.
4. Keeps inside air moving to flush hot, moist air from among the birds.

To adequately handle a heat wave, the ventilation system should have:

1. A total exhaust fan capacity of 3.5 litres per second (L/s) per laying hen (7 cubic feet per minute (cfm) per laying hen);
2. A total intake opening area of 0.18 m^2 per 500 L/s (2 sq. ft./1,000 cfm);
3. Air-inlet baffles that can be adjusted to give an even flow of fresh air to all areas without restricting the fans; and
4. A static pressure monitor in place and operating so that it shows the amount of suction or negative pressure exerted on the building by the exhaust fans.

The exhaust fan capacity of a laying house is the total capacity of all exhaust fans. To obtain information on the

capacities of fans, take the sizes, make and model numbers of the fans and call the supplier or your local agricultural engineer. When discussing fans with a supplier, always obtain the capacity at 0.10 in. water gauge (W.G.) static pressure.

If certified capacity ratings are unavailable for the exhaust fans in your laying house or for fans you plan to purchase, then use Table 1 as a guide.

Table 1. Approximate fan capacities for selected fan sizes[1]

Size			Capacity @ 0.10 in. W.G. static pressure	
mm.	in.	H.P.	L/s	cfm
450	18	1/3	1400	3000
600	24	1/3	1700	4000
750	30	1/2	3300	7000
900	36	1/2	4200	9000
1050	42	3/4	5600	12000
1200	48	3/4	6600	14000

[1]*Most good quality fans properly installed will meet or exceed these ratings.*

Fan Installation

Mount fans in solid frames and seal all cracks around the frames.

Make sure that the fan blades on all fans with sharp-edged orifices are mounted on the shaft so that one-third of the blade width is outside the orifice and two-thirds of the blade width is inside.

Air Intakes

To provide a uniform distribution of fresh air to caged layers, the air intake should be continuous along the length of the cage rows. One inlet should serve no more than two or three cage rows. A house with four rows should have air inlets on both sides.

The opening through the wall or over the plate must be of adequate size. If not, the flow of fresh air into the house will be restricted when the maximum ventilation rate is required. The required width of air-intake opening is listed in Table 2 for various numbers of birds per m and per ft. of intake.

First calculate the number of birds per m or foot of intake for your house by dividing the total number of birds by the total intake length.

For example: 20,000 birds are housed in four 250 ft. long cage rows. There is air intake on both sides. The number of birds per foot of intake is 20,000/500 or 40. From Table 2 the required air intake opening width is 6.7 inches. If constructing the air intake over the plate, make sure that the width of screened opening in the soffit is at least 6.7 inches and also that there is at least a 6.7 inch wide opening through the ceiling.

Use the test indicated in Table 2 also for existing caged layer houses. If you are seriously short of intake opening area, add an additional continuous intake or reconstruct existing intakes to a larger size.

Table 2. Required width of continuous "through-the-wall" or "over-the-plate" intake opening.

A. Metric		B. Imperial	
No. of Birds /m of intake length	Required width (mm)	No. of Birds /ft of intake length	Required width (in.)
80	100	24	4
120	150	36	6
160	200	48	8
200	250	60	10
240	300	72	12
280	350	84	14
320	400	96	16

Ventilation System Management

Air-inlet baffles must control the inlet air to provide proper air movement, even distribution and proper house static pressure. Automatic baffle controllers using a static pressure sensor are recommended. A typical installation is shown in Figure 2.

Figure 2. Automatic baffle control

Without automatic baffle control, adjust inlet baffles to keep the house static pressure within an acceptable range as fans turn on and off. In hot weather, aim for 0.05 in. W.G. In cold weather, 0.08 in. W.G.

A heat stress problem can occur any time during the year if the ventilation system fails to work properly. In winter when large fans are covered and outside doors on air-intakes are closed, it is important to ensure that there is adequate back-up fan capacity to cool the barn. An equipment failure at this time is just as serious as in the summer. Check the high temperature warning system regularly year round and be especially sure that winter fans are in working order.

What does Heat Stress do to Laying Hens?

While laying hens may occasionally die as a result of heat stress in Ontario, this is not the major economic consequence. Most laying hens adapt to the stress, but in the process, many aspects of their lives, internally and externally, undergo radical change. We will concentrate here on the external, visible changes.

Hens continually adjust their feed intake according to

environmental temperature. Up to about 27°C this fluctuation in feed intake does not affect production unless an important nutrient is marginally deficient. Above 27°C, the bird's body temperature rises and a much more dramatic reduction in feed intake can be anticipated. The data below (Table 3) were collected in different parts of the same house, where different average maximum temperatures were recorded. Feed intake

Table 3. Effect of temperature on feed consumption, egg size and body weight.

	Temperature °C			
	27.5	29.2	30.8	31.7
Feed intake (g/day)	113.7	102.2	101.5	94.4
Body weight (g)	1589	1441	1400	1478
% Medium and Below	32.3	48.4	56.3	66.7

Source: D.R. Sloan & R.H. Harms, 1984. Univ. of Florida, Poultry Science, Volume 63, Supplement, page 38.

appeared to fall 20% while temperature rose by 4.2°C

As feed intake declines, the first production trait to respond is egg weight. The changes shown in Table 3 reflect a drop in the average weight of the eggs, from coolest to hottest environment, of approximately 3.0 grams (g) per egg with the resultant increase in medium and small eggs. This seems to be largely due to the reduction in the absolute amount of protein ingested at the higher temperature.

As temperatures rise above 32-35°C, egg production levels may also decline, as total nutrient intake is insufficient to support normal rates of lay.

Perhaps the most frequent result of heat stress is a decline in egg shell quality. Occasionally, this may be due to inadequate calcium intake, but this is rare, since most commercial layer feeds provide enough calcium to support shell formation even at low feed intakes. The maximum daily calcium intake recommended for most layers is 4.0 g. This would be obtained if the hen consumed 90 g of a feed containing 4.4% calcium, or a feed with 3.6% calcium plus 20 kg oyster shell supplement per tonne.

Most of the shell quality problems arising from heat stress are **not** the result of dietary calcium deficiency. Rather, they result from extremely complex metabolic changes within the hen. As the bird pants to keep cool, excess carbon dioxide is exhaled. This causes the blood to become more alkaline, and reduces its ability to hold and carry calcium for shell formation. Such a situation **cannot** be remedied by increasing dietary calcium.

Various other blood minerals are affected by heat stress. One of the most important is phosphorus, and the requirement for this element is increased at high temperatures. Marginal phosphorus levels, when combined with heat stress, can lead to increased mortality rates, particularly among older birds.

As a result of the increased water intake, moisture content of droppings will escalate in hot weather. This can provoke difficulties in the handling and storage of manure where the system depends on dry manure. It can also lead to increased soiling of egg shells, either directly from soiled feathers, or from splashing in shallow manure pits.

There is considerable evidence that the immune system of the bird is adversely affected by heat stress. Therefore, administration of vaccines to pullets or layers is not usually recommended during very hot weather.

Furthermore, where vaccines are spray administered, the closing down of the ventilation system to permit proper vaccine distribution is impractical in extremely hot conditions. If vaccinations cannot be avoided, they should be restricted to the coolest time of the day, when the adverse effects of reduced ventilation are at a minimum.

High temperatures may also result in less efficient utilization of vitamins, and certain vitamins in feed are themselves less stable in these circumstances.

The effects of heat stress will all be aggravated by other environmental factors such as increased bird density, feed and/or water deprivation, inadequate ventilation, vaccine reaction and the presence of diseases or parasites.

RECOMMENDATIONS FOR MINIMIZING HEAT STRESS IN CAGED LAYERS

Ventilation

1. Provide a minimum of 3.5 L/s (7 cfm) per bird of exhaust fan capacity. This may require two air changes per minute in a high-density cage house.
2. Air inlets should be properly adjusted, especially when using baffle boards, to achieve a uniform flow of air throughout the length of the building. Buildings with more than three rows of cages require inlets on both sides.
3. Assess air movement in the barn with the use of a static pressure monitor (manometer). Problem barns should be smoke tested. Consult your local agricultural engineer for assessment of your ventilation system.
4. Proper maintenance of exhaust fans requires inspection and cleaning of shutters, adjusting belts, and proper hood placement to protect against wind gusts. Baffles, intakes, thermostats, motors, shutters and hoods should be cleaned and adjusted on a regular basis. Up to a 50% loss of efficiency may result from poor maintenance of ventilation equipment. All electrical equipment should be routinely inspected by your electrical contractor.
5. Check belt drive fans for belt alignment and correct belt tension.* Both too much and too little tension can reduce fan performance and cause early belt failure. In addition, too much tension can cause bearing failure while too little tension can cause drive sheave failure.

** An A size belt has the correct tension when a four to six lb. force will deflect the belt 1/64 in. per inch of belt span. Belt span is the distance the belt is straight between two sheaves.*

6. Stand-by generators and alarm systems should be properly maintained and tested monthly with results recorded in a log book. High-low temperature alarm systems should be set in the sensitive range so that the farm manager can react to elevated temperatures quickly.
7. Foggers and misters properly installed and maintained could reduce losses due to heat stress provided air changes occur as described in text.
8. Buildings should be properly insulated. New buildings should have R20 for walls and R28 for ceilings to reduce radiant heat gain. Provide screened or perforated soffits and ridge ventilators for attic ventilation.
9. Grass and vegetation should be mowed regularly especially on the air-inlet side of the building.
10. Wide open doors and inlets will cause the static pressure (negative pressure) to drop, resulting in a loss of air speed. Air speed aids in heat loss through convection.

Water

1. Monitor water consumption. Ten thousand layers in full production will consume 2,000 L per day during normal environmental temperatures. Above 32°C water consumption can increase up to 50%. Ensure that water pipes are properly sized to prevent water shortages bearing in mind peak demand.
2. Water system management must ensure adequate pressure and volume of cool water throughout the length of the building. Pressure regulators and water filters need to be serviced regularly. It is advisable to flush water lines prior to anticipated heat periods. Check water flow and temperature gauges at the far ends of the building during the warmest part of the day.
3. Water treatment with polyphosphates and/or chlorine may be necessary to prevent build up of iron-mush bacteria and mineral deposits.
4. In most cases, water quality has a greater effect on equipment then upon the **direct** health of the birds.

Feed and Lighting

1. During hot weather it is extremely important to monitor feed consumption daily, to ensure an adequate intake of nutrients on a per bird basis. This is particularly important for the 24 to 30 week old pullet. Special feed formulations do exist for summer feeding. Consult your feed company for details. Stirring existing feed within the trough by operating feed lines between feedings helps increase consumption. Running the feeders early in the morning will stimulate feed consumption during the cooler hours of the day.
2. The lighting system time clocks should be set to come on in the early morning, cooler hours, i.e. before 6:00 a.m.

Egg Quality

1. Eggs should be collected more often and cooled down immediately in a properly equipped egg storage room to maintain internal egg quality.
2. Extra care should be taken in handling the eggs in hot weather, due to reduced shell quality.
3. In shallow pit operations producing liquid manure, arrange clean-out immediately following egg pick up, to minimize the effect of splashing.

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